AIR CONDITIONING OF INTERIOR SPACES IN HUMID CLIMATES, LESSONS LEARNED

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INTRODUCTION

Hawaii has a humid environment. Reference TM-785. For various locations in Hawaii, our exterior ambient design condition for a majority of locations in the State of Hawaii is 86 degrees F at 61% RH. Conditioning of indoor spaces is required year-round. Per TM-785, we have 0 heating degree days. With the requirement to provide year-round cooling, and an ambient environment that is humid during a majority of the year, we are faced with a challenge to provide an indoor environment that provides appropriate comfort cooling, sufficient ventilation air for health, and acceptable humidity control.

Several design references contain instructions on how to provide air conditioning in humid environments. Commonly used in Pacific Ocean Division are:

1. Army ETL 1110-3-455 titled, AHumidity Control for Barracks and Dormitories in Humid Areas@.

2. Air Force ETL 93-2 titled, ADormitory Criteria for Humid Areas@.

3. AAir-conditioned Building in Humid Climates, Guidelines for Design, Operation, and Maintenance@ issued by Southern Division, Naval Facilities Engineering Command.

4. AMold and Mildew in Hotel and Motel Guest Rooms in Hot & Humid Climates@ by the American Hotel and Motel Assc.

5. ASHRAE Technical Bulletin titled AControl of Humidity in Buildings@.

A common challenge that we in POD face is moisture infiltration into the conditioned space through unconditioned air sources (infiltration through leaks or intentional introduction by design). This infiltration results in unacceptable humidity levels in the conditioned space. One major problem that manifests itself is the formation of mold and mildew, which creates maintenance as well as potential health problems for the

occupants. From the above references, humidity levels in the 60%-93% RH range and a temperature window of 77 degrees F to 86 degrees F, are ideal for the propagation of mold and mildew.

WAR STORIES

PROJECT: FY 91 MCP DORMITORY, HICKAM AIR FORCE BASE, HAWAII
CUSTOMER: US AIR FORCE PACIFIC COMMAND

In a property exchange arrangement, the State of Hawaii built a Dormitory for the Air Force at Hickam. Air conditioning of the individual rooms was provided by fan coil units (FCU). PACAF instructed Corps designers to copy the State of Hawaii Dorm Project. Corps reviewers cited the customer=s own criteria (AF ETL 93-2) that specifically disallowed the use of fan coil units for AC. Customer directed designer to copy state design. Soon after the completion of the FY91 Dorm (the first of several new and renovated dorms that POD produced for the Air Force), the occupants began to find mold and mildew on interior surfaces of the dorm rooms. POD was called in to assess the problem. Determination was made that the air conditioning strategy (fan coil units with unconditioned outside air for ventilation/make up) did not adequately control humidity levels within the individual dorm rooms. As a result, mold and mildew growth occurred. One recommendation was the possible use of new fan coil units being produced to control humidity for the hotel industry in Florida. (Discuss Prototype FCU) User has not decided on what course of action they will take. However, they concur that original recommendation to follow AF ETL should have been followed.

Lesson learned

Although *the customer is always right*, we need to be patient, and educate them to *show them what is right*.

PROJECT: FY88 MCP ALTER ELECTRIC POWER PLANT, KAENA POINT SATELLITE TRACKING STATION, HAWAII
CUSTOMER: US AIR FORCE SPACE COMMAND

Project consisted of converting one existing building (formerly a maintenance shop) into a UPS Equipment room. Contractor completed the room and user installed UPS equipment under a separate contract. The new AC system that Corps contractor installed was put into operation. It was designed to maintain a temperature setpoint of 60 degrees F (mostly sensible load). Shortly thereafter, room was overrun with tremendous mold/mildew growth. Every acoustical ceiling tile in the room had turned charcoal color and warped. Interior cmu walls covered with mildew. POD called in to assess. It was found that several problems existed. Designer failed to recognize existing roof penetrations that were already part of the existing building, which allowed uncontrolled unconditioned air movement into the space. Existing double doors on the windward side to the building had no weather treatment. Kaena Point is known for its consistent strong winds. Again, uncontrolled unconditioned air movement into the space. The new AHU had several penetrations into the equipment casing for control wiring and refrigerant piping. Although required by contract to be sealed, they were not. These were located on the suction side of the fan downstream of the cooling coil. Unconditioned air was being drawn into the supply air system, and blown into the space. Sling psychrometer readings revealed RH in the 80%-90% range. Temperatures were recorded in the high 60s. Contractor corrected AHU deficiencies, Customer sealed doors, and Government issued change to have all roof penetrations sealed. Problem was resolved.

Lesson learned

Proper design must examine not only heat load, but also investigate air leakage sources especially on retrofits. QA/QC must ensure proper installation of equipment.

PROJECT: STOP LEAKING IN WAREHOUSE, BUILDING 160, TRIPLER ARMY MEDICAL CENTER, HAWAII
CUSTOMER: US ARMY MEDICAL COMMAND

Project required installation of several walk in refrigerators, including one that would provide an interior space held at 50 degrees F and 30% relative humidity for the purpose of medical film storage. The design strategy was to use special low temperature dehumidifiers to maintain the low RH. Once these refrigerators were completed, the contractor was required to test each reefer to ensure that the design temperature and humidity setpoints were achieved. Contractor was unsuccessful in obtaining the desired 50 degree F/30% RH condition in the film reefer. QA rep noted that condensation was observed inside this reefer at the seams in the reefer panels. Contractor tightened up reefer and condensation problem resolved. However, relative humidity in the box was still much higher than the 35% RH specified (in the 70% range). POD called in to assess. For fear of mold/mildew formation, and because of schedule impact to the customer, quick resolution was a high priority. Possible sources of infiltration were examined. No signs of condensation at door, panel seams, or light fixtures. Condensate drain in the reefer which was located under the FCU between the two dehumidifiers was examined. Test was performed to seal the drain (to eliminate moisture introduction from the drain=s trap). Condensation from the FCU and the two dehumidifiers was removed manually. Still no improvement in humidity control. In an attempt to see if the dehumidifiers were operating properly, QA was directed to observe dehumidifier operation. Did the two units cycle on an off, or did they run continuously? QA rep reported that the two low temperature dehumidifiers cycled on and off. Manufacturer=s operating instructions were then reviewed. At that point contractor called in to correct humidity setpoint adjustment on the two units to lower the humidity in the reefer. The contractor had not bothered to select the proper humidity setpoint for each dehumidifier, and had installed them Aas is@ out of the box. This resolved the problem.

Lesson learned

Go back to the basics. Make sure that all equipment is operating properly before other tests are done. Read the manufacturer=s installation instructions.

CONCLUSIONS

Although air conditioning design is a mechanical discipline, let us not forget that architectural features of buildings definitely affect the ability of the AC equipment to provide the desired quality of the indoor environment. Mechanical designers need to coordinate with all other disciplines, especially architects, to ensure that all aspects of the building have been considered. When dealing with renovation/retrofit projects, field investigations need to be thorough to ensure that all sources of leakage through the building envelope have been properly addressed. Designer=s need to educate the customer to ensure that the customer understands what is technically required, so that the customer will make the right choices. Contract documents (plans and specifications) need to be tight so that the designer=s intended end product can be built. Lastly, a solid design is meaningless unless proper QA/QC delivers the correct product.

SOMETHING TO THINK ABOUT

Liability is or should be of great concern to the designer, design agent and building owner. Attachment A shows a listing of the type of spores found on one project in which humidity control was poor. High humidity in the occupied spaces resulted in the formation of major mold and mildew contamination. It was determined that the abundance and type of spores found posed a health threat to those that would perform repair to the damaged interior. These workers were then required to wear personnel protective gear including HEPA face masks and tyvek suits. Imagine what would happen if someone got sick.

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